INTRODUCTION TO PILOT PROJECTS UPDATES

The following pilot projects vere presented in Belfast 1999 and scheduled for updating in Copenhagen 2000:

1. Danish Products Oriented Environmental Measures in the textile industry
   Denmark
2. Pollution Prevention Tools
   USA
3. Energy efficiency in Moldova
   Moldova
4. Water Conservation and Recycling in Semiconductor Industry: Control of Organic Contaminaiton and Biofouling in Ultra Pure Water systems
   USA and United Kingdom
5. Clean Processes in the Turkish Textile Industry
   Turkey
6. Cleaner Production through the Use of Intelligent Systems in the Pulp and Paper industry
   Canada
7. Clean Products and Processes in the Textile Industry
   USA
8. Cleaner Energy Production With Combined Cycle Systems
   Turkey

In the following abstracts and/or papers present the status and progress of the pilot projects, presented in the chronological sequence in which they were scheduled for presentation for the Copenhagen meeting (not all pilot project managers were present in Copenhagen).

POLLUTION PREVENTION TOOLS

Subhas K. Sikdar
USA

Last year we discussed the utility of several design tools that were in development at the National Risk Management Research Laboratory. PARIS II, a solvent design software, has been completed and transferred to TDS, Inc. (New York City) for marketing. Beta testing has just started with 50 companies participating. PARIS II program designs, in the computer, solvent mixtures with reduced environmental impact (such as toxicity and other measures) that match the property profile of the solvent mixture being used currently. Further information on PARIS II is available in chapter on Computer Tool Café. Waste Reduction (WAR) algorithm was developed for flow sheet-based cleaner process design. The measure used to express a degree of "cleanliness" is potential environmental impact (PEI), which is a user-chosen composite of a set of chemical and non-chemical impacts, such as human toxicity, eco-toxicity, ozone depletion, global warming, etc. WAR has been incorporated in the latest version of the commercial process simulator Chemcad (Houston, TX). A more advanced product has been recently completed. This is an integrated design tool that combines WAR with Aspen Plus and the commercially available costing package Icarus. The EPA Office of Enforcement and Compliance is planning to use this tool in helping industry to reduce waste generation and emissions. With this integrated tool, a complete analysis (including production, cost, and environmental) of a process facility can now be done. For more information, please enquire at cabezas.heriberto@epa.gov and young.douglas@epa.gov.

DETECTION AND CONTROL OF MICROBIOCONTAMINATION IN ULTRAPURE WATER PROCESSES

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Bacterial contamination of water is a common problem that threatens many of its industrial uses; particularly in the microelectronics industry where ultrapure water is utilized in the rinsing stage of microchp manufacture. Although ultrapure water is an environment almost completely depleted of nutrients, a group of microorganisms, termed oligotrophs, can adapt to these stringent conditions. The objective of this project is to detect and control the bacterial contamination in an ultra-pure water (UPW) system. The project is carried out in collaboration with laboratories in the University of Arizona, New York State University at Buffalo and the New Jersey Institute of Technology (NJIT). The project is coordinated By Professor John O'Hanlon at the University of Arizona Centre for Microcontamination Control (CMC) and much of the work is based around their substantial "state-of the-art" microprocessor research and pilot production facility and its ultrapure water (UPW) system. Described here will be the role of the QUESTOR Centre group in identifying contaminant microorganisms by using sophisticated microbiological analysis and in the development of microbiological expertise for the other laboratories. Initially this has involved characterisation of microbial contaminants in the CMC UPW system then validation of detection systems developed at Buffalo and control systems developed at NJIT.

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REVIEW OF PROGRAMS IN CLEANER PRODUCTION (POLLUTION PREVENTION)

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Introduction

Cleaner production and pollution prevention are relatively new concepts in the environmental field, but are now advancing within NATO and other European countries. Defining cleaner production is often best done with the use of a hierarchy, Figure 1. Technologies, operational procedures, and management techniques that are nearer the top of the hierarchy are referred to as cleaner production. However these approaches also generally meet two other criteria,

1) technologically feasible
2) cost-effective

This double hurdle has focused pollution prevention to a series of case studies or projects that have evolved rapidly and innovatively. One of the largest collection (about 13,000) of these case studies can be accessed at http://www.P2PAYS.org. With this conceptual definition of cleaner production there are several terms that identify closely related activities:

In order to better understand the contribution that pollution prevention has made, a study was made of the development of this field among the members of a NATO/CCMS project (Sikdar, 1998). The author wishes to acknowledge that this study would not have been possible without the exceptional assistance of all the individual members of this project.

Methodology

The NATO/CCMS project represented initially about 18 countries. This has expanded to 23 and these countries serve as the database for this study. Review of the data tables of this paper indicates the participating countries. Each country representative participated in defining the parameters used to characterize cleaner production overall and within the textile industrial sector. This definition lead to a standardized set of questions from which the answers could be analyzed to present a picture of the evolution and the partial nature of cleaner technology. The selection of textiles coincided with a related emphasis of other studies in the NATO/CCMS project.

* (Acknowledgement of NATO/CCMS Fellowship support. Conclusions are those of the author and do not necessarily represent views of the CCMS or of NATO member countries)

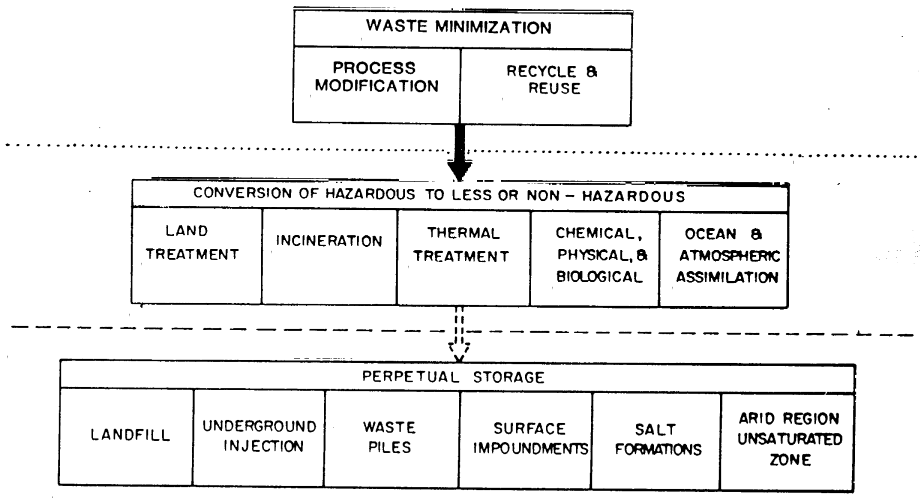

Figure 1 Relationship of alternate waste reduction concepts to overall hierarchy of hazardous waste management

Results

The development of a pollution prevention program within a State (as illustrated by the U.S), a region (as illustrated by the Dnieper River/Black Sea Project for the Ukraine), or a whole country generally occurs with several initial events or activities. These include

- Concept Conference
- Legislation
- Education and training of industrial or consulting personnel
- Demonstration of clean technology in industry

For each country, the approximate date and activities initiating their clean production program are given in Table 1. Using five year time periods, the initiation of cleaner production is illustrated in Figure 2 and 3. There were a smaller number of countries in the first decade and now a much greater penetration in 1990 - 2000. In Figure 2, the time to organize and complete the initial pollution prevention activities appears to be 3 - 5 years. Such information can help countries to realistically judge the time a resource requirements for a cleaner production program.

Resources are required to successfully introduce the concepts and benefits of cleaner production; and then, to have these adopted more widely by industry. A number of organizations (government and non-government) have been committed to stimulate pollution prevention in various countries. These resources seem to have been successful. A listing of such early financial and technical support for cleaner production is given in Table 2. An number of countries and the U.N. are repeatedly recognized as having provided resources to begin the shift toward cleaner production approaches in the environment.

As pollution prevention evolves within a country, various industrial sectors appear more active in adopting and implementing cleaner production. This also changes with time. The survey identified the three industrial sectors with significant pollution prevention activity in 1999, Table 3. Across all participating countries, the frequency of current planning and/or use of cleaner production, by sector, are given in Figure 3. A wide variety of industrial types are presented. The most common are chemicals, metal finishing/electroplating, and textile manufacturing, as these represent both large numbers of facilities and areas with extensive pollution prevention case studies to gain credible ideas. The industrial progress, Figure 3, is often the result of cleaner production advocacy, which has made resources available, increased the awareness, and encouraged technical innovation. Which groups are currently the more prominent advocates of cleaner production was surveyed, Table 4. Again ;a great deal of diversity is found, but universities and government organizations appear to be the most active advocates during the latest years.

PILOT PROJECT UPDATES

Table 1. Early Events in the Creation of Cleaner Production Programs

Country	Approximate Beginning Year for Cleaner Production Programs	Conference on Concept of Cleaner Production	Legislation	Education/Training	Industrial Demonstrations
Bulgaria	1995	Not Major Mechanism	National Plan for Healthy nation and Sustainable Development (1995) National Plan for Ecological Activities (1998) Municipal Action Plan (1999)	University Staff Training and student Ecology Courses (1999)	NATO for Peace/ Bulgarian Academy of Science Regional Project on Black Sea (1999) EU Fifth Framework Projects (1999)
Czech Republic	1992	Not Major Mechanism	Government Resolution on Cleaner Production (2000, proposed)	Czech-Norwegian Training Program (1992)	1992
Denmark	1976 – 1979	Not Major Mechanism	Statutory Order for Recycling and Minimization of Wastes (1984) Danish Government Plan (1988) Environmental Protection Act No. 358 (1991)	Common Nordic Project	Nordtextil VA (1976-79)
Country	Approximate	Conference on	Legislation	Education/Training	Industrial

	Beginning Year for Cleaner Production Programs	Concept of Cleaner Production			Demonstrations
Hungary	1997	Not Major Mechanism	Not Major Mechanism	1998	1998
Israel	1998 – 1999	Not Major Mechanism	Not Major Mechanism	Not Major Mechanism	ISO 14000 (1998 - 1999)
Italy	1987 – 1988	Not Major Mechanism	Interministerial Committee for Industrial Planning (1990)	Not Major Mechanism	National Research Council and National Association of chemical Industries (1992)
Japan	1999	Not Major Mechanism	Not Major Mechanism	Not Major Mechanism	Not Major Mechanism
Lithuania	1993	Waste Minimization Opportunity audits in Lithuanian Industry (1993)	Lithuanian Laws on Waste Management (1997) National Program for Cleaner Production and Environmental Industry Development (1998)	Pilot Project (Lund University, Danish Environmental Management Center, and Kaunas University of Technology (1993) Norwegian-Lithuanian Cleaner Production Training Program (1995)	Pilot project (1993) Waste Minimization in Chemical Industry, world Environment Center (1993) Implementation of Cleaner Production in Lithuanian Tanneries (1996)

Country	Approximate Beginning Year for Cleaner Production Programs	Conference on Concept of Cleaner Production	Legislation	Education/Training	Industrial Demonstrations
Poland	1991	Not Major Mechanism	Act on Protection and Management of the Environment & Polish Movement for Cleaner Production (1997)	Norwegian-Poland Cleaner Production Program (1991)	1991
Portugal	1993	New Environmental Technologies and Business Strategies (1993)	Not Major Mechanism	ADAPT (1993)	First Portuguese Cleaner Production Program; Programe for Sustainable Production at Setubal (1994)
Romania	1995	Not Major Mechanism	Environmental Protection Law (1995) Sustainable Development in Romania (1999)	Not Major Mechanism	Not Major Mechanism
Slovak Republic	1994	Cleaner Production (1995)	Not Major Mechanism	1994	1994
Turkey	1996	Not Major Mechanism	National Environ-mental Action Plan; Mediterranean Plan UNEP 1997	1997 -1999	1997 - 1999

Country	Approximate Beginning Year for Cleaner Production Programs	Conference on Concept of Cleaner Production	Legislation	Education/Training	Industrial Demonstrations
Ukraine	1994	Industrial Environmental Problems and Technology in Dnieper River and Black Sea (1995)	Not Major Mechanism	Pridneprovie Cleaner Production Center Non-Profit/Non-Governmental (1994) Consultant Training (1995)	Projects in Transport, Agriculture, and Industrial Audits (1995)
United Kingdom	1990	Not Major Mechanism	Environmental Protection Act (1990) Environmental Technology Best Practice Program (1994)	Department of Trade and Industry (1993)	Aire and Calder Project (1992)
United States	1976 – 1979	Making Pollution Prevention Pay (1982)	Not Major Mechanism	North Carolina State Office of Science and Technology and North Carolina State University (1980)	3M Corporation 1976

Figure 2 Approximate Initiation Date for Textile Cleaner Production - NATO/CCMS Study Members

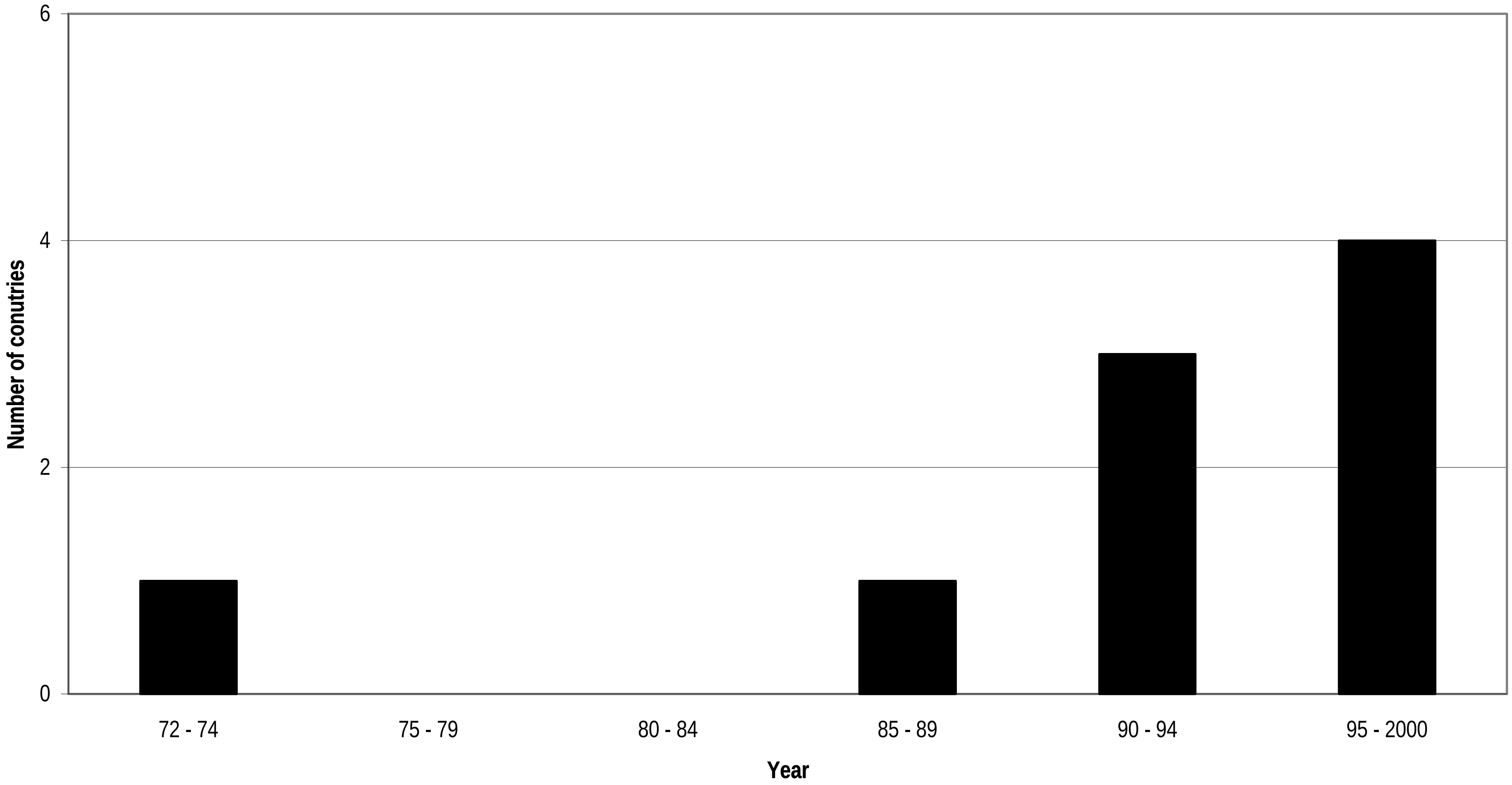

Figure 3 Historical Dynamics of Cleaner Production Efforts - NATO/CCMS Study Members

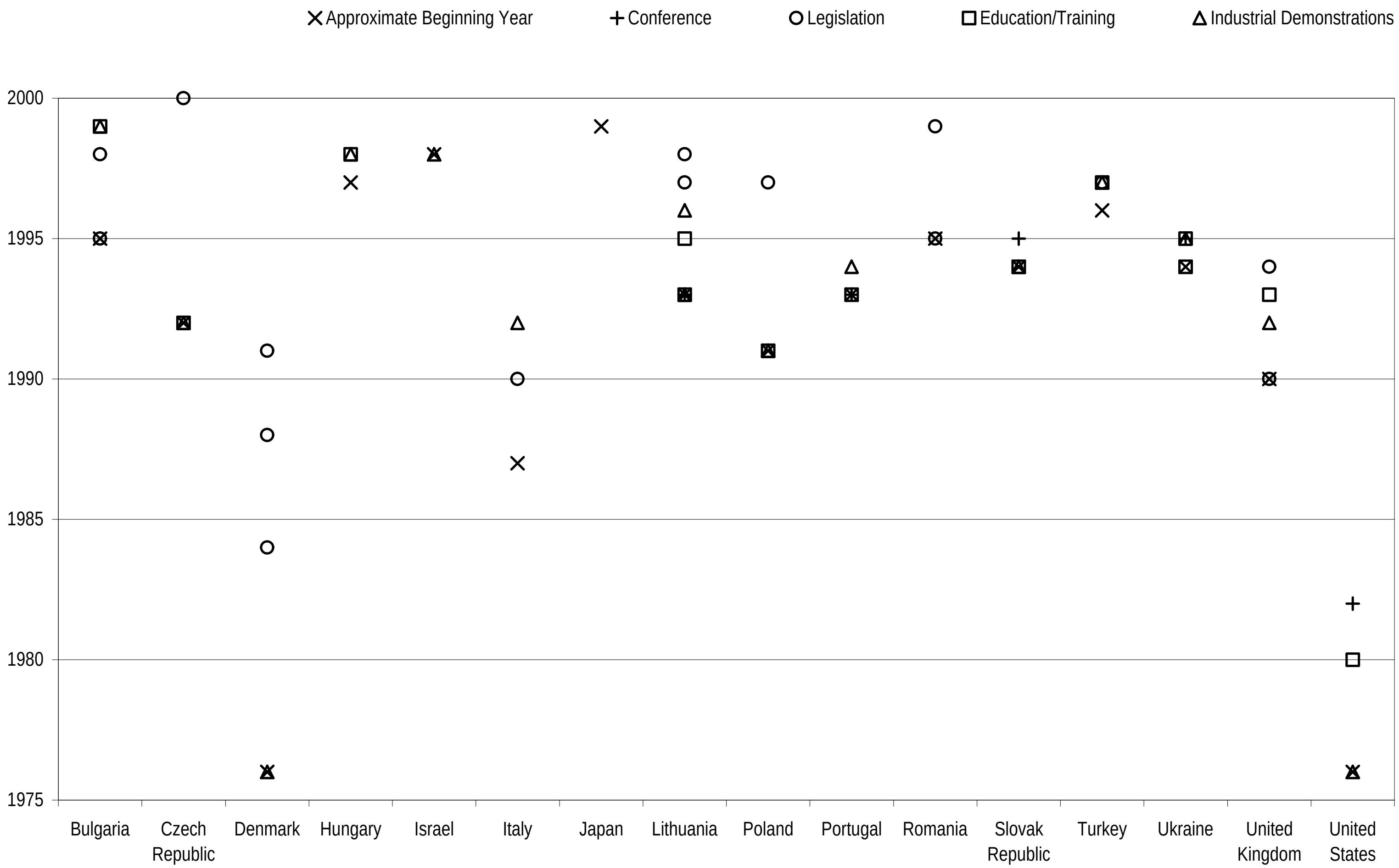

Table 2. Exchange Programs to Initiate Cleaner Production

Country	Early External Support for Cleaner Production
Bulgaria	NATO for Peace; Bulgarian Academy of Science Regional Project on Black Sea; EU Fifth Framework (1999)
Czech Republic	UNIDO/UNEP National Cleaner Production Center (1995)
Denmark	None
Hungary	UNIDO/UNEP (1997)
Israel	None
Italy	None
Japan	None
Lithuania	Sweden (1993); Danish Environmental Management Center (1993); World Environment Center (1993); Norway (1995); University of Amsterdam (1998)
Poland	Norway (1991); World Environment Center/USAID (1992)
Romania	None
Slovak Republic	USAID; UNEP; World Environment Center ; Norway: Austria: Holland (1994)
Turkey	World Bank (1997); Danish Technological Institute(1997)
Ukraine	None
United Kingdom	None
United States	None

Table 3. Industrial Sectors with Significant Current Activity (1999) in Cleaner Production

Country	Recent Sectors (3) That are Active in Cleaner Production		
Bulgaria	Chemical Industry	Ferrous/Non-Ferrous Industry	Small/Medium Firms
Czech Republic	Municipal Water and Sewer Services	Public Transport	Food and Agriculture
Denmark	Textiles	Metal Finishing and Electroplating	Graphics and Printing Industry
Hungary	Automobiles	Graphics and Printing Industry	Chemicals
Israel	Chemicals	Pharmaceuticals	
Italy	Textiles	Leather Industry	
Japan			
Lithuania	Textiles	Food Processing	Electronics
Poland	Public Services (Water, Rail,Power)	Food and Agriculture	Metal Finishing and Electroplating
Portugal	Metal Finishing and Electroplating	Chemicals	
Romania	Pulp & Paper	Textiles	
Slovak Republic	Public Sector	Chemical	Food and Agriculture
Turkey	Textiles	Metal Finishing and Electroplating	White goods Manufacture
Ukraine	None at this time		
United Kingdom	Chemicals	Graphics and Printing Industry	Metal Finishing and Electroplating
United States	Chemicals	Metal Finishing and Electroplating	

Table 4. Network of Current Advocates for Cleaner Production (1999)

Country	Current Leading Advocates (3) of Cleaner Production		
Bulgaria	Bulgarian Academy of Science	University of Chemical Technology and Metallurgy, Sofia	Technical University, Sofia
Czech Republic	Center for Cleaner Production UNIDO/UNEP	Municipal Officials	Several Universities
Denmark	Universities	Government Offices	NGO
Hungary	Universities	Consulting Firms	
Israel	Ben-Gurion University	Technion – Israel Institute of Technology	
Italy	Ministry of Industry	Association of Chemical Industries	Ministry of Environment
Japan			
Lithuania	Association of Textile Industries		
Poland	Supreme Technical Organization (NOT)	Universities	Government Research Institute (GIG)
Romania	Universities		
Slovak Republic	Slovak Cleaner Production Center and Regional Environmental Centers	Ministry of Environment	Slovak University of Technology
Turkey	Industry Associations	Clean Technology Institute of Marmara Research Center	
Ukraine	Pridneprovie Cleaner Production Center	Ukrainian State University of Chemical Engineering	Severodonetsk State Institute of Chemical Technology
United Kingdom	Center for Exploitation of science and Technology	Advisory Committee on business and the Environment	Consultants
United States	State Roundtable	Industry	U.S. EPA

Textiles

This industrial sector has emerged as an active arena for the development and implementation of cleaner production concepts. Some of these changes have occurred over as many as twenty years and thus a success profile or widely adopted (as commercially attractive) technology profile has emerged. These widely accepted cleaner production practices for textiles were summarized, Table 5 and Figure 4. The three most successful practices are,

1) water (and hence energy) conservation thus reducing the volume of effluents
2) a methodical evaluation and demand for reduced toxics in the large number of specific chemicals or proprietary formulations used in textile facilities
3) a recapitalization to obtain more efficient dye equipment.

The dynamics of new developments in cleaner production for textiles led to R & D concepts which appear promising. These emerging concepts were surveyed in each country and a number of technologies were identified, Table 6. However, the most frequently identified , as an emerging technologies, were the following:

1) use of membranes to achieve further water conservation
2) supercritical CO_2 processing.

One aspect of this NATO/CCMS project is to stimulate technology transfer. Such activity is facilitated by the broader knowledge of individuals with specific interest and expertise in textile cleaner production. Hence this project has sought to identify a pollution prevention network in the textile field. The results, Table 7, provide names and affiliation, but also means of direct contact (preference given to email, then fax, and then snailmail). This current work has facilitated the creation of a specialist network by the assembly of information. Network uses might be to summarize work and experience of each individual, to promote some joint projects such as collection or transfer of specific cleaner production information, development of new, leading edge cleaner production techniques for the textile field, or serving as experts in helping small and medium textile firms throughout the world.

Table 5. Generally Successful Textile Cleaner Production Concepts in Various Countries

Country	Approximate Start of Cleaner Production for Textiles	Most Commercially Attractive Cleaner Production Concepts in Textiles (3-6)
Bulgaria	No Formal Program	1) Use of Natural Fibers
Canada	No Formal Program	1) Reduction or Elimination of Toxics and Halogenated Chemicals 2) Equipment Change for Lower Bath Volumes per kg fabric 3) Operational Changes 4) High-Extraction, Low-Carryover Process Step Separations
Czech Republic	Ecolabelling (1994)	1) Reduction or Elimination of Toxics and Halogenated Chemicals
Denmark	1972	1) Reduction or Elimination of Toxics and Halogenated Chemicals 2) Equipment Change for Lower Bath Volumes per kg fabric 3) Water Reuse
Hungary	1999	No Current Changes
Israel	No Formal Program	1) Requirement for Biodegradable Detergents 2) Reduction or Elimination of Toxics (metals)
Italy		
Japan	No Formal Program	
Lithuania	1997	1) Good Housekeeping Improvements for Water , Energy, and Chemicals
Poland		
Romania	No Formal Program	
Slovak Republic	1994	1) Water Conservation 2) Toxic Dye Minimization
Turkey	1997	1) Detergent Elimination After Fixed Reactive Dyeing 2) Water Softening to Reduce In-process Chemical Use 3) Water Reuse
Ukraine	1990	1) Water Reuse
United Kingdom	1995	1) Reduction of Solvent Loss in Dry Cleaning 2) Reduction of Formaldehyde 3) Recycling of Water and Energy 4) Reduction in Toxics Use
United States	1985	1) Equipment Change for Lower Bath Volumes per kg fabric 2) Raw Material Quality Control to Lower Unwanted Chemical Inputs 3) Worker Training 4) Technology Transfer to Small/ Medium Firms

Figure 4 Broadly Cost-Effective Textile Cleaner Production Techniques - NATO/CCMS Study Members

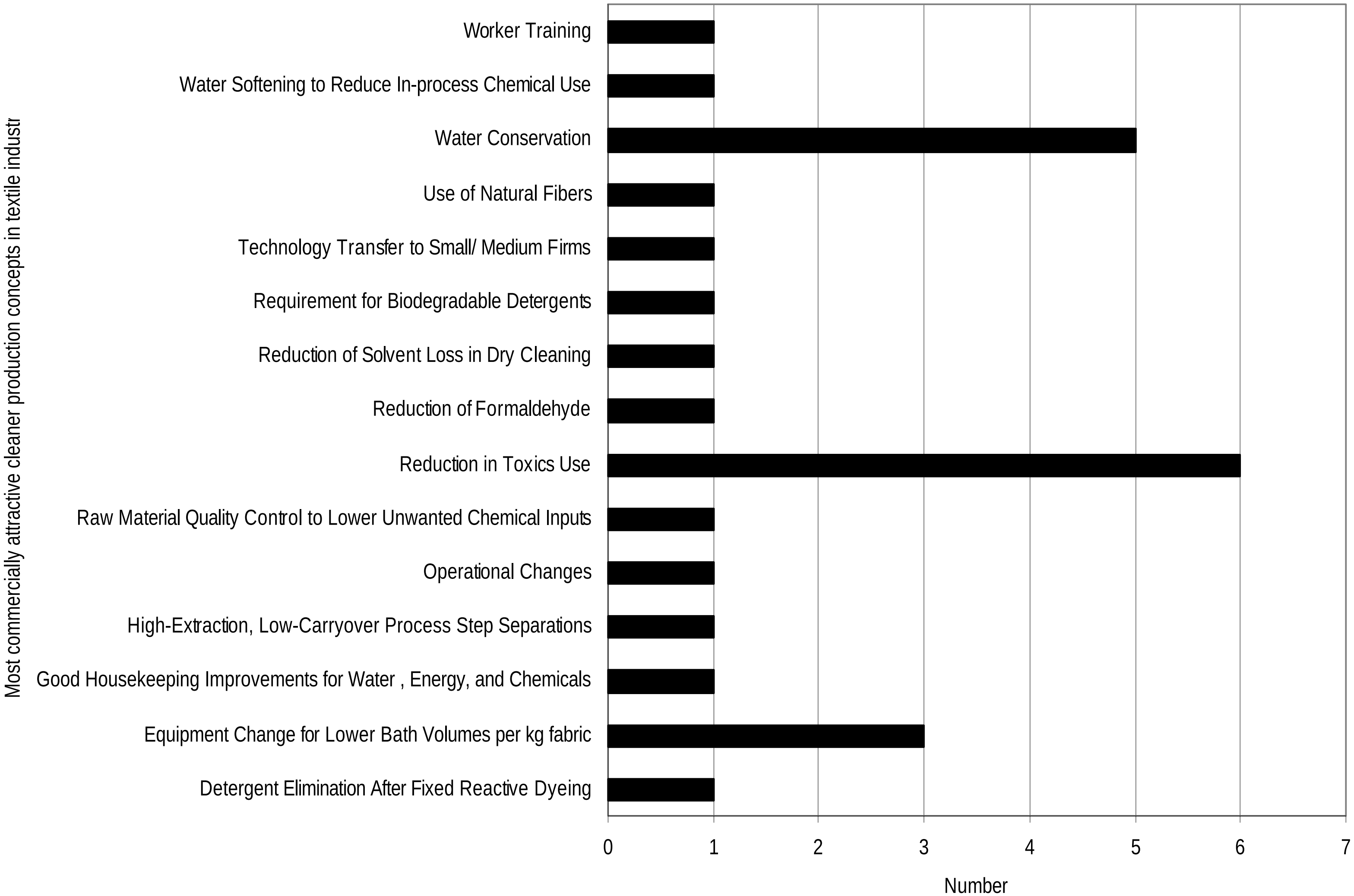

Table 6. Emerging Technologies in Various Countries for Increased Textile Cleaner Production

Country	New Concepts for Textile Cleaner Production
Bulgaria	1) Adoption of Wastewater Treatment 2) Waste Audit for Leather Industry
Czech Republic	1) Systematic Use of Environmental Management Tools (EMS, EMAS, ISO 14000)
Denmark	1) Water Reuse with Membrane Filters 2) Other Water and Energy Reuse
Hungary	1) Adoption of Ecotext Standards
Israel	1) Recycling of Water
Italy	
Japan	No Formal Program
Lithuania	1) Water Reuse 2) Energy Reuse
Poland	
Romania	No Formal Program
Slovak Republic	1) Water and Energy Audits and Minimization 2) Better Quality of Inputs
Turkey	1) Water and Energy Reuse with Membranes 2) Capture of Carbon Dioxide from Flue Gas
Ukraine	1) Vapor condensation to Impregnate Fibers
United Kingdom	
United States	1) Communication and Information Systems to Unify the Textile Complex 2) Supercritical Carbon Dioxide Processing

Table 7. Network of Specialists for Cleaner Production in Textile Industry

Country	Industrial or Technical Experts in Textile Cleaner Production		
Bulgaria	Prof. Nikolay Petkov Simeonov University of Chemical Technology and Metallurgy 8 Kliment Ohridski Str. 1176 Sofia, Bulgaria tel. 359-2-625-4488 fax. 359-2-989-0545	Prof. Ekaterina Ivanova Teriemezjan University of Chemical Technology and Metallurgy 8 Kliment Ohridski Str. 1176 Sofia, Bulgaria tel. 359-2-625-4433	
Canada	Dr. Jess Shen Crechem Technologies 1200 Montreal Road Building M-2, suite 209 Ottawa, Ontario K1A 0R6, Canada Tel. 1-613-993-4383 Fax. 1-613-941-1571	Chantal Roberge, Manager Strategic Options Process for the Textile Mill Effluents Environment Canada 105 McGill St. 4th Floor Montreal, Quebec H2Y 2E7, Canada tel. 514-496-6850 fax. 514-283-5836	
Czech Republic	Ing. Pavel Bartusek Inotex, Ltd. Stefanikova 1208 544 01 Dvur Kralove nad Labem Czech republic Tel. 42-437-820-140 Fax 42-437-820-149 Inotex@inotex.cz	Ing. Petr Janak Inotex, Ltd. Stefanikova 1208 544 01 Dvur Kralove nad Labem Czech republic tel. 42-437-820-140 fax 42-437-820-149 inotex@inotex.cz	Ing. Jan Marek Inotex, Ltd. Stefanikova 1208 544 01 Dvur Kralove nad Labem Czech republic tel. 42-437-820-140 fax 42-437-820-149 inotex@inotex.cz

Country	Industrial or Technical Experts in Textile Cleaner Production		
Denmark	John Hansen Danish Technological Institute P.O. Box 141 DK-2630 Taasatrup, Denmark Tel. 45-4350-4350	Hans Henrik Knudsen Institute for Product Development Building 424 Technical University of Denmark DK-2800 Lyngby, Denmark tel. 45-4525-4666 hhk@ipt.dtu.dk	Henrik Wenzel Institute for Product Development Building 424 Technical University of Denmark DK-2800 Lyngby, Denmark tel. 45-4525-4663 wenzel@ipt.dtu.dk
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Israel	Prof. Rebhun Department of Civil Engineering Technion Tel. 972-4-829-2360	Dr. Noah Galil Department of Civil Engineering Technion tel. 972-4-829-2360	Prof. Amotz Weinberg, President Shenkar College of Textile Technology and Fashion tel. 972-3-575-9064
Italy			
Japan			

Country	Industrial or Technical Experts in Textile Cleaner Production		
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Poland			
Romania			
Slovak Republic	Ing. Jaroslav Ceveik CHTF STU Radlinskeho 9 812-37 Bratislava, Slovak Republic tel. 421-7-5932-5251 sefcikj@cvt.stu.sk	Ing. Milan Kuuhavy MAYTEX, A.S. 1 Maja 136 031 17 Liptovsky Mikula, Slovak Republic tel. 421-849-553-5250 fax. 421-849-551-4831 maytex_sale@isternet.sk	Ing. Jioi Chlumsky Slovak Cleaner Production Center Pionierska 15 831 02 Bratislava, Slovak Republic tel. 421-7-4445-4328 fax. 421-7-4452-9015 sccp@cpz.sk

Country	Industrial or Technical Experts in Textile Cleaner Production		
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Ukraine	Prof. William Zadorsky Pridneprovie Cleaner Production Center P.O. Box 4159 Dnepropetrovsk-2, 320002 Ukraine Tel. 380-562-416-550 Fax. 380-562-416-590 Ecofond@ecofond.dp.ua		
United Kingdom	Chris Marshall Dept. of Trade & Industry 151 Buckingham palace Road London SW1W 9SS, UK 44-171-215-1451	British Textiles Technology Group Shirley House Didsbury, Manchester M20 8RTX, UK 44-161-445-8141	
United States	Prof. Brent Smith College of Textiles Box 8301 North Carolina State University Raleigh, NC 27695-8301, USA Tel. 1-919-515-6548 Fax. 1-919-515-6532 brent_smith@ncsu.edu		

Conclusions

The progress in development of cleaner production in various countries has occurred for about twenty years and continues even in the last five years. The typical process of bringing cleaner production to a country involves training and industrial demonstrations. A period of three to five years appears as average to achieve an introduction of pollution prevention, although the extent of adoption or implementation varies. In 1999, as a measure of current cleaner production activity, the most active sectors appear to be chemicals, metal finishing/electroplating, and textiles manufacturing; while universities and government organizations remain the most widely perceived advocates.

As a specific industrial sector, textiles is one of the most active over the last decade. Across numerous countries, the most types of cleaner production success (technically viable and economically feasible) were found to be

1) water conservation
2) methodical reduction of toxics through supplier requirements
3) more efficient dyeing equipment.

In the next decade, the development of technologies for membrane systems leading to water or energy conservation and supercritical carbon dioxide were felt to be likely candidates. Finally a network of about thirty textile cleaner production specialists was identified.

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CLEANER PRODUCTION IMPLEMENTATION FOR WET PROCESSES OF COTTON TEXTILES

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Introduction

Turkey’s textile and ready wear sector plays a key role in the country’s industrialisation. In 1997, 20% of the total industrial establishments operating in the textile sector employed 30% of all industrial workers. The most successful sub-sector of the Turkish textile industry has been the cotton sector. Turkey is the seventh largest cotton producer in the world with a share of 4%.

Because of having a very important impact on the country’s economy, textile industry has been given priority from the point of Cleaner Production (CP) implementations. The qualitative and quantitative patterns of both the production process and the related resource utilisation are of great importance within the framework of CP. This study is carried out within the frame of project “ Conducting Research and Development aimed at Developing Cleaner Production Technologies to Assist Textile Industry to Manufacture in Compliance with International

Standards”. It has been the first activity of the implementation of Cleaner Production Methodology Cleaner Production in Turkey.

Cleaner Production in Cotton Textile Industry for Turkey
The CP program for the textile industry in Turkey has to comprise of a set of organisational, administrative and planning activities that aim at enhancing the CP approach throughout the production the production of fabric.

Three of the six selected enterprises in this project are engaged with wet treatment processes of cotton textile industry. For this reason, the “possible CP options” are selected with special emphasis on wet processes.

Wet processing stages were taken into account from the point of resource(s) conservation. In general, wet treatment processes such as bleaching, dyeing and finishing are very important in terms of the environmental aspects of textile production, not only because of the vast quantity of water and variety of chemicals used, but also because of a high thermal energy requirement. Water and energy are, therefore, also significant cost elements for most production units.

The costs associated with the material and energy in and outflows were investigated. During the evaluation of water costs, both industrial water preparation and wastewater treatment were considered. Furthermore, discharge costs for treated wastewater were also included. With a clear insight into these costs, management can be usually convinced to agree to rapid implementation of CP, particularly with respect to chemical substitution. Within this framework, extensive CP options were subsequently developed.

Before the Feasibility Stage, the generated set of CP options were prioritised. The prioritised options which seemed to be most promising were then submitted to a feasibility study. The feasible options could subsequently be recommended to the enterprise, with implementation carried out under a regime of continuous monitoring and evaluation.

Evaluation of Possible CP Options
After the assessment phase being carried out to select the CP options for feasibility study, it has been observed that there are variety of operations leading to different types of energy and water consumption. Also dye stuff and chemical consumption due to teh differences in the processes vary to a high degree. For this reason it was quite hard to develop a reliable mass and energy balances for the whole and selected product systems . As a result of the feasibility study was carried out on the prioritised CP options by taking into account the environmental, technical and economical issues.

Since technology changes tend to be capital intensive, the selected CP options are preferred to be focused on modification of the existing processes and substitution of chemicals. The priority is always given to prevent the effects on the quality of the fabric.

The process that has been implemented frequently is selected for reduction in chemicals. In Table 2 the chemical and dyestuff input for one t-shirt in comparison with a more environmentally friendly t-shirt are compared. For the recipe reactive dye is used. The fixation of reactive dyes differ between 50-80%. The type of reactive dye used for this process has a fixation value of 48% which is very low in comparison with the range of the reactive dye stuff.

High amounts of salt is added during dyeing to increase the fixation values. The reactive dye stuff result in high content of Chloride (9800mg/l) color (3890) and disolved solids (12500 mg/l).

For an environmentally friendly t-shirt production dyestuff and auxiliary material consumption should be minimised. For this reason, detergent and acetic acid consumption is reduced. Forly BS-C has adverse effects on the wastewater. It has both ecotoxicity impact potentials and human toxicity impact potentials. It is usage is omitted completely (Table 2).

Table 2. Inputs and outputs of chemicals and dyestuff for the selected wet treatment recipe of the knitted conventional t-shirt and the environmentally friendly t-shirt.

Process	Inputs	Conventional t-shirt		Environmentally friendly t-shirt	
		Input amounts (g/ t-shirt)	Output amounts (g/ t-shirt)	Input amounts (g/ t-shirt)	Output amounts (g/ t-shirt)
Bleaching	Wetting agent (Albegal NF)	3.21	2.56	3.21	2.56
	Anticrease (Imacol S)	1.73	1.38	1.73	1.38
	Hydrogen peroxide	3.45	2.76	3.45	2.76
Dyeing	Acetic acid	1.73	1.38	1.38	1.10
	Anticrease (Imacol S)	1.73	1.38	1.73	1.38
	Sequestrant (Uniperol SE)	0.86	0.69	0.86	0.68
	Sodium Chloride	108.7	87	108.7	86.96
	Antiperoxide (Perzym Red DC)	1.73	1.38	1.73	1.38
	Dye (2%Ambifix Brillant Orange V-3R(reactive dye)	4.96	2.58	4.96	3.96
	Sodium Carbonate	4.96	3.96	4.96	3.96
	Detergent (Forly BS-C)	1.57	1.25	-	-
	Caustic	8.62	6.89	8.62	6.89
Finishing	Softener (Rottamin RC)	1.16	0.93	1.16	0.92
	Acetic acid	0.22	0.18	-	-
	Soap (Imerol XN)	0.15	0.12	0.06	0.05

Table 3. Information related to the “Material Safety Data Sheets (MSDS) of some chemicals).

Auxilaries	Physical Form	Hazard Symbol	According to EEC Biological Elimination	LD_{50} (mg/kg) [x]	LC_{50} (mg/kg) [xx]	EC_{50} (mg/kg) [xxx]
Imerol XN	Liquid		>80%	>2000	22	>100
Rottamin RC	Liquid dispersion	None	100%	>3000	10-100	>5000
Badena 243	Liquid dispersion	None	>90	>2000	>1000	>100
Roflex GA/PN	Liquid dispersion	None	>90	>2000	>1000	>100

[x] rat-oral
[xx] fish toxicity-salmo gairdneri, oncorhynchusmykiss, routine bioassay method of 1.11.74
[xxx] test of OECD 209
X_n : contains etoxylated fattyalcohol. Contains nonylphenol
X_I : contains salt of phophated fatty alcohol
None : No hazard classification according to EU Guidelines

After addition to the reduction in the chemical amount, research for substitution of chemicals is carried out. For this purpose Imerol XN (soap) and Rottamin RC (softener) are substitute with Roflex PAD (soap) and with Badena 243 (softener) respectively. From Table 3 it can be seen that with the substitution of chemicals the adverse impacts on the environment can be reduced.
In addition the Cp option mentioned above another option for which feasibility study was also done can be summarized as follows:

Description: To reduce the liquor ratio of the baths without creating any negative effect on the result of the process is the main target of this option. For the machine with 600kg capacitythe liquor ratio is decreased from 1:7 to 1:4. Also the enterprise has to pay 0.3884 DM/m^3 to Istanbul Sewage and Water Organization.
Investment : Neither capital investment nor running investment is necessary for this CP option.
Net income: 16.86 DM/day.
Others: There will be a labour work reduction by 0.9 DM/day.

In order to investigate the saving in chemicals and conservation of water and energy, the results are evaluated by taking into account the production per day and results can be seen in Table 4.

Table 4. Reduction on liquor ratio of baths for rinsing processes.

		Before implementation	**After implementation**	**saving**	**Environmental evaluation**
Input					
Electricity	(Kwh/d)	880.2	874.332	5.868	Energy Conservation
Chemicals H_2SO_4, Lime, $FeCl_3$	(kg/day)	1,923.08	1,909.58	13.5	Reduction of chemicals that are used for in the wastewater treatment plant.
	(DM/day)	291.32	289.30	2.02	

Water	(m^3/day)	1,800	1,788	12	Water conservation
	(DM/day)	1,818	1,805.88	12.12	
Output					
Chemicals H_2SO_4, Lime, $FeCl_3$	(kg/day)	1,162.5	1,153.2	9.3	Reduction of chemicals that are used for in the wastewater treatment plant.
	(DM/day)	160.5	159.22	1.28	
Wastewater (DM/day)		1176.6	1167.19	9.41	Water conservation and reduction in wastewater.

The same process modifications of liquor reudction are calculated for one knitted cotton t-shirt (Table 5).

Table 5. The comparison between conventional and environmentally friendly processes from the point of water and energy conservations.

Process	Input	Conventional t-shirt		Environmentally friendly t-shirt	
		Input	Output	Input	Output
Bleaching	Energy kW/t-shirt	13.93	13.93	13.91	13.91
	Water l/t-shirt	1.37	1.09	1.23	1.0
Dyeing	Energy kW/t-shirt	44.04	44.04	42.38	
	Water l/t-shirt	5.47	4.38	4.87	3.9
Finishing	Energy kW/t-shirt	35.18	35.18	34.17	
	Water l/t-shirt	5.47	4.38	4.87	3.9

Conclusions

A textile plant has been investigated thoroughly by means of a step-wise CP Methodology Application. The evaluation of the feasibility studies revealed that it is worth implementing CP options from the point of resource conservation and chemical substitution. The benefits obtained were not only attributed to cost savings, but better environmental awareness as well.

It should be noted that the CP options studied are feasible only for that production system for that selected enterprise.

It is concluded that the successful application of CP methodology in the Turkish textile sector will encourage other industrial sectors to take similar actions. It should also be noted that the managerial commitment of any enterprise is of utmost importance in CP, since without their commitment and financial support, there will be no real actions and no real results.

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CLEANER ENERGY PRODUCTION WITH COMBINED CYCLE SYSTEMS

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Energy demand in the world is increasing everyday due to the increase in population and economic developments. Electrical energy is the most favorable clean energy which is generally produced by conventional systems known as Pulverized Coal-Fired or Stoker-Fired Boilers with steam turbine and generator systems. In these systems, the energy conversion efficiency is around 30-35 %. Only about one-third of the heat generated can be converted to electrical energy.

There is a great amount of research going on in several countries to increase the energy production efficiency as well as the development of new processes and equipments which use much less energy than the ones developed decades ago.

A new technology for generation of electrical energy in a cleaner and more efficient way is the Combined Cycle (CC) system. The conversion efficiency of the system is about 50-53 %, which is considerably higher than the conventional systems. The presentation summarized the energy production capacity in Turkey with combined cycle systems by using several fuels. Updates were given on the development of sorbents used for gas cleanup of the IGCC systems by using the waste materials of the iron and steel industry.

THE DANISH CENTRE FOR INDUSTRIAL WATER MANAGEMENT – UPDATE

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The Danish Centre or Industrial Water Management (Danish acronym: CEVI) is a co-operation between five large Danish companies, three technological institutes and two universities. The aim of the centre is to develop concepts and solutions for reclamation and reuse of water and waterborne energy and chemicals in water consuming industry. Generic methods and tools must be developed for future anchoring and dissemination of the developed know-how, and solutions must be implemented within the industrial partners, being representatives from textile industry, industrial laundering, paper industry and food industry.

CEVI has been running now for one year out of four, and a number of results have been achieved ranging from generic methods to implementation of solutions. Among the methods developed, adjusted and/or applied are: Methods for mass-, energy-, and cash flow analysis, methods for characterising and specifying water quality and product quality, methods for process integration and pinch analysis, and methods for environmental feasibility analysis in shape of a simplified Life Cycle Assessment method.

In industrial laundering, being one of the case industries, direct water reuse saving 40% of the water has been implemented through establishment of central tanks for reuse water at one laundry. Moreover, biological treatment has been installed for further water reuse. Ultrafiltration of the wash baths has been successfully tested in lab- and pilot scale, and test are under conduction for full scale washing in UF permeate saving thus both the water and the energy and chemicals remaining in the water.

Present and future R&D comprises recovery of surfactants and phosphorus from UF concentrates from wash water, drying in overheated steam, membrane filtration (NF/RO) of process water from polyester yarn dyeing, aerobic and anaerobic digestion of process water from moulded pulp production, and much more. The following tables give an overall view of research, development and implementation progress.

Table 1. Status on generic methods May 2000

Type of method	**Method/tool elements**	**STATUS**
Overall procedures	• Process optimisation • Equipment modernisation • Chemical substitution • Reuse of water, energy and chemicals	Conceptually defined
Inventory	• Processes • Mass flows • Energy flows • Cash flows	Initially defined Adjusted and applied Adjusted applied Developed and applied
Analysis and system design	• Water quality characterisation • Product quality characterisation • Product quality specification • Water quality specification • Process integration/energy • Process integration/mass • Database of separation techniques • Guidelines in choice of water reuse Concepts and techniques • Database of residue management Options • Guideline in residue management	Developed and tested Developed and tested Not defined Defined on case basis Adjusted and tested Adjusted and tested Under consideration Under consideration Under consideration Under consideration
Modelling	• Water- and product quality in water reuse scenarios	Existing tools tested Excel tool developed and successfully tested
Feasibility study	• Technical feasibility • Economic feasibility • Environmental feasibility • Robustness/sensitivity analysis	Under consideration Applied Developed and applied Developed and tested on a case basis

Table 2. Berendsen Industrial Laundry Group. Status on research, development and implementation, May 2000

PROCEDURE LEVEL	Activity	Status
Optimisation	• Various water, energy and chemical savings • Automatic weighing of textile for optimal chemical dosing	Established at 3 laundries. Pinch analyses conducted Suggested
Modernisation		
Substitution		
Reuse	• Direct reuse via central water reuse tanks. Around 40% water savings • Biofilter for reclamation and reuse of wash water • Membrane filtration of the wash water • Membrane biofiltration of the wash water • Environmental comparison of alternative water reuse concepts • Heat recovery from drying. Drying in superheated steam	Implemented in one line (8 washing machines) at one laundry Installed at two laundries. Test of operation ongoing Successfully tested in lab-scale and pilot-scale. Washing tests with permeate ongoing Successfully tested in pilot-scale Conducted Under consideration

Table 3. Neckelmann polyester yarn dyehouse. Status on research, development and implementation, May 2000

PROCEDURE LEVEL	Activity	Status
Optimisation	• Spray system for CIP installed – substitutes two complete tank fillings • Liquor displacing unit used when cleaning dyeing apparatuses	Established in one out of 14 dyeing apparatuses Constructed and tested - minor reconstruction ongoing
Modernisation	• Reduction of water carry-over by vacuum suction of the yarn cones between the batches of the recipe	Under consideration
Substitution		
Reuse	• Direct reuse via central water reuse tanks • Reduce volume of oily UF concentrate by salt addition and subsequent gravitational separation • Membrane filtration of the heaviest polluted water types • Evaporation techniques and heat recovery • Heat recovery from drying. Drying in superheated steam	Reuse of water from last rinse as input to first rinse successfully tested Successfully tested and installed Successfully tested in lab-scale. Pilot-scale tests ongoing Process integration/pinch analyses carried out. Feasibility study ongoing Under consideration

Table 4. Hartmann moulded pulp producer. Status on research, development and implementation, May 2000

PROCEDURE LEVEL	Activity	Status
Optimisation	• Reduction of water content of products before drying	Under investigation
Modernisation		
Substitution	• Substitution of biocides by dispersing agents	Tests ongoing
Reuse	• Direct reuse via flotation and central water reuse tanks • In-line aerobic biological treatment for microbial growth control and for reducing use of biocides • In-line aerobic biological treatment for microbial growth control and for reducing use of biocides • In-line NF/RO membrane filtration for microbial growth control and for reducing use of biocides • Environmental comparison of alternative water reuse concepts • Heat recovery from drying. Drying in superheated steam	Implemented for many years Successfully tested in pilot scale Lab- scale tests ongoing Unsuccessfully tested in pilot scale Conducted Under consideration

PILOT STUDY UPDATES